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# A REVIEW OF AN EFFECT OF CANOLA OIL LUBRICATION WITH NANO MOLYBDENUM DISULPHIDE ADDITIVES ON MACHINING

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***ABSTRACT***

***There is a huge development in the utilization of advanced materials for high performance applications. These materials settle a lot of mechanical issues and they present extensive test in machining because of poor machinability qualities. Machining is one of the essential and irreplaceable procedures in the production industry. Amid the machining procedure the heat produced in the cutting zone which is basic in choosing the work piece quality. Despite the fact that different cutting fluids are utilized to take away the heat in machining, their usage results in destroying nature and affecting the health of the workers. Oil impacts the cutting zone because of arrangement of film layer which decreases rubbing between the mating surfaces which results lowering temperature and improve the surface finish. In a few examinations it is accounted for that presentation of nano particles in cutting fluids prompted great execution in machining to diminish cutting forces, temperature and improved surface finish of the work piece along these lines improving efficiency and decreasing risks to health and preferred condition over traditional MQL process. The molybdenum disulfide [$MoS_2$] is broadly utilized as solid lubricant material, it's potential as a successful medium in MQL points of interest in processing activity yet to be investigated. Therefore the use of $MoS_2$ nano particles in machining activities as for surface finish, cutting forces, tool wear and temperature at the cutting zone are evaluated.***

***KEYWORDS: Canola Oil, $MoS_2$, Nano Lubrication, Additives in Lubrication & Machining***

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A REVIEW

## INTRODUCTION

Cutting fluids are the basic part of machining process as it cools the cutting zone, lubricates the tool chip in contact and hence lowering the friction and temperature produced at the cutting zone [1]. The significant offer of cutting fluids being utilized over the world is petroleum based oils. Colossal utilization of petroleum based oils had a negative impact on nature and health related results like skin infections [2]. Petroleum based lubricants in 2016 have expanded massively on high worldwide utilization, appearing least 1% yearly additions with 13,726 million tons of oil comparably [3]. In spite of their high usage, they present huge health and ecological perils throughout their life cycle. Change of the metal working enterprises towards supportable manufacturing can be found in the impediment of the utilization of traditional coolant and coolant systems. It is accounted for that about 80% of every word related illness of workers in the manufacturing industry were because of skin contact with cutting liquids [4].

The interest for biodegradable and eco-friendly cutting fluids has opened a way for utilizing vegetable oils as a potential option in contrast to oil based cutting fluids [5]. Vegetable oil-based cutting fluids are very biodegradable, eco- friendly, sustainable, less lethal, high flash point, low instability, high viscosity index, wide generation conceivable outcomes, and efficient in the waste administration [6]. Being biodegradable, administrator amicable, liberally accessible, and reasonable, vegetable oils have been altogether tested to look at their appropriateness as lubricants in machining activities. Canola oil, Rapeseed oil, coconut oil, sunflower oil, etc., are a portion of the vegetable oils which drawn the interest of the researchers, offering ascend to fascinating outcomes. Every one of these elements incited examinations concerning the utilization of biodegradable coolants or coolant free machining. Henceforth, as an option in contrast to cutting fluids, researchers tested dry machining, coating tools, cryogenic cooling, vegetable oils, minimum quantity lubrication (MQL) and solid lubricants. By their higher biodegradability and lower ecological effect the utilization of vegetable oil in metal working applications may ease issues looked by workers, such as skin malignancy and inward breath of harmful fog in the workplaces.

Minimum Quantity Lubrication (MQL) alludes to the utilization of an accuracy gadget to supply a miniscule measure of cutting fluid to the tool-work piece interface – normally at a stream rate of 50 to 500 ml/hour – which is around three to four requests of size lower than the sum ordinarily utilized in a flood cooling condition [7]. The utilization of MQL is of extraordinary hugeness related between extensive cutting fluids application and dry machining. It can decrease the measure of frictional heat generation and give some cooling in the tool-work piece interface and henceforth keep the work piece temperatures lower than those in a totally dry machining. Another application for this innovation is that when appropriately connected, the two parts and chips stay dry and are simpler to deal with [8]. MQL in examination with flood cooling and dry machining radically limit (1/300,000 times) the negative impact on the nature and operator's physiology, coming about because of plentiful utilization of coolant in milling and lessens the cutting force impressively in correlation with dry cutting individually [9]. As indicated by the performed investigations, the MQL strategy can be a choice to flood cooling in some milling activities, particularly speed milling. Be that as it may, there is a need to build up its execution to machine hard to cut materials such. Thus, nano fluids have been created by including nanometre estimated particles of metals, oxides, carbides, nitrides, or nano tubes, such as carbon nano tube, $TiO_2$ (Titanium Dioxide), $Al_2O_3$ (Aluminium Oxide), $MoS_2$ (Molybdenum Disulphide), and diamond to the cutting fluids. These nano additives can upgrade the thermal conductivity and lubrication of the cutting fluids and improve the execution of MQL technique.

## MATERIALS AND METHODS

Nano fluids are new classes of fluids designed by scattering nano meterized materials (nano particles, nano fibers, nano tubes, nano rods and etc) typically in the scope of 1~100 nm in based fluids which could be deionized water, mineral, esters or vegetable oils [10]. Solid lubricant-assistedmachining has developed as one of the novel systems. $MoS_2$ has caught the eye of researchersinferable from their tribological properties. This material is portrayed by weak atomic interactions between their layered structures, permitting low-quality shearing. Other than this, nano incorporated manufacturing has increased adequate significance to bestow maintainability prompting environmentally safe engineering systems $MoS_2$ in its nano particulate structure has extraordinary tribological properties, which can lessen friction under outrageous pressure conditions. Selected properties of $MoS_2$ are shown in Table 1.

**Table 1: Properties of Molybdenum Disulfide [11]**

| | |
|---|---|
| Molar Mass | 160.07g/mol |
| Appearance | Black |
| Density | 5.06g/cm$^3$ |
| Melting Point | 1185°C |
| Solubility in water | Insoluble |
| Crystal Structure | Hexagonal |

The scanning electron microscopic (SEM) images depicting the microstructure of $MoS_2$ nano particles are shown in Figure 1.

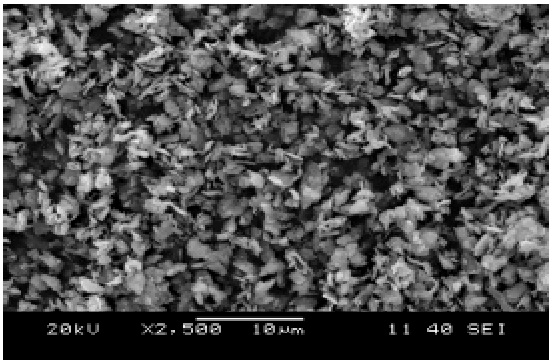


**Figure 1: SEM Image of Microstructure of $MoS_2$ at X2500 Magnification [11]**

They construed that, the physical and chemical properties of surface films rapidly developed by $MoS_2$ dry lubricant are significant and the principle explanation behind its great frictional conduct. The vegetable oil base gives a predictable arrangement of liquid's lubricity to the metal work piece. These variables lead to broad utilization of vegetable oils in various applications [12]. A Figured cutting liquid of Canola with 8% extraordinary pressure added substance indicated lower forces, tool wear, and surface roughness esteems for turning [13]. Canola oil based cutting fluids create better surface finish and produce lower cutting and feed forces while turning [14]. Canola oil delivered from the seeds of Brassica napus and Brassica rapa. Selected physical properties of canola oil at the temperature of 20°C are shown in Table 2.

**Table 2: Physical Properties of Canola Oil [15]**

| | |
|---|---|
| Density | 0.94-0.97g/cm$^3$ |
| Kinematic Viscosity | 78.2mm$^2$/sec |
| Smoke point | 220-230°C |
| Flash point | 275-290°C |
| Specific heat | 1.910-1.916J/Kg |
| Thermal Conductivity | 0.179-0.188W/m°K |

## EFFECT OF NANO FLUID ON MACHINING PARAMETERS

Nano fluid incorporated with MQL lubrication used to improve machining execution of milling process. The impacts of ideal MQL coordinated with MWCNTs with dry cutting and unadulterated MQL on the cutting force, cutting temperature, tool wear and surface roughness under same cutting conditions. The cutting force and cutting temperature were estimated by a KISTLER dynamometer and a FLIR A320 infrared thermal imager separately. The surface roughness meter (Mitutoyo, SJ-210) used to recognize the surface quality. Tool wear value measured with SEM (JSM-6380, JEOL) and a measuring microscope [16].

**Cutting Force**

A broad investigation to examine the execution of MQL machining as for the procedure parameters was discovered that utilization of MQL amid machining diminished the tangential cutting forces up to a huge cut off particularly while machining is done at low cutting speeds [17]. High speed face milling tests on aluminium alloy A356 at various cutting seeds up to 5225 m/min under various cutting situations of dry, flood and MQL. The most astounding cutting forces were observed for machining under dry conditions and least cutting forces were observed for machining under flood cooling. The cutting forces under MQL lubricating conditions were lower than that under dry machining yet it was somewhat higher that forces created under flood cooling [18].

**Surface Roughness**

The impacts of solid lubricant helped machining with graphite and $MoS_2$lubricants on surface quality, cutting forces and explicit vitality while machining AISI1045 steel utilizing cutting tools of various geometries. The friction created between the tool and the work piece has been essentially diminished in $MoS_2$ helped machining as contrasted with graphite-assisted and wet machining. The lubricant adequacy in limiting the friction in the tool and work piece association on account of solid-lubricant-assisted machining is clear from the decreased cutting forces contrasted with that of wet machining. It is significant that the solid lubricant ought to hold fast emphatically to the metal surface else it would be effectively scoured away and would give exceptionally short service life just as lubricating $MoS_2$ helped machining results in lower cutting forces because of its grip inclination acquired from free electrons. The specific energy devoured amid $MoS_2$ helped machining is low and a normal decrease of 28 percent as contrasted and wet machining is reported. $MoS_2$ machining yielded better outcomes in diminishing surface roughness [19].

**Tool Wear**

The heat generated in the essential and the auxiliary shear zone influences the wear of tool materials. The MQL turning task performed on AISI 4140 steel and the outcomes were contrasted with machining under dry and flood lubricating conditions. Maximum surface roughnesswas observed for machining under dry ecological conditions while least measure of surface harshness was gotten for machining under MQL conditions. This was on the grounds that machining under MQL lubricating conditions brought about lesser cutting forces, therefore decreasing the heat generated and most extreme temperature of the chip tool interface, Due to this temperature decrease, adhesive and dissemination wear of the tool was diminished which encouraged in adding to the improved surface finish of the last product[20].

**Environmental Aspects**

Machine operators are influenced by ruinous impacts, for example, skin and breathing issues brought about by the presence of certain fixings like chlorinated paraffin in extreme pressures (EPs) and other synthetic added substances in ordinary cutting fluids [21]. Utilized oil contains a higher measure of halogens, particularly chlorine is treated as exceptional waste, causing very surprising expenses of transfer [22]. Moreover, new cooling techniques have their very own concern. For example, in spite of the fact that MQL is introduced as an environmental friendly cooling method, gas pressure vanishes and appropriates some volume of cutting fluid noticeable all around which could be unsafe for machine operators so MQL does not ensure operators from respiratory issues [23]. Despite the fact that minimum quantity lubricant (MQL) can be considered as an agreeable domain cooling strategy since the fluid vaporizes amid the procedure, leaving dry chips, MQL utilizes cutting fluids as fog which expands health hazards for the operators. Be that as it may,

vegetable based nano fluids can be considered as proper strategy to lessen ecological and word related dangers since these liquids are sustainable and have elevated amounts of biodegradability.

## RESULTS AND DISCUSSIONS

The morphology of surface delivered by end milling of AL6061-T6 alloy on a vertical machining centre utilizing $MoS_2$ nano oil. The examinations were led utilizing normal lubrication as the main method of lubrication and nano-upgraded lubricant having $MoS_2$ nano particles in common oil as the second mode. The groupings of $MoS_2$ nano particles in base oil were 0.0, 0.2, 0.5 and 1.0 wt%. In this examination, FESEM and XRD systems were utilized to analyze the morphology and phase of the machined surface. FESEM gives topographical and elemental data at different amplifications with a for all intents and purposes boundless depth of zone while XRD examination gives the quantitative volume parts of minerals in a sample. The presence of $MoS_2$ nano particles in lubricant improved the machined surface quality because of the rolling, filling and polishing activities at the machining zone. From the outcomes, it was seen that 0.5 wt% $MoS_2$ nano molecule concentration produced the least surface roughness. In any case, when the concentration was expanded to 1wt%, a decrement in the surface quality was seen as appeared in Figure 2 [24]

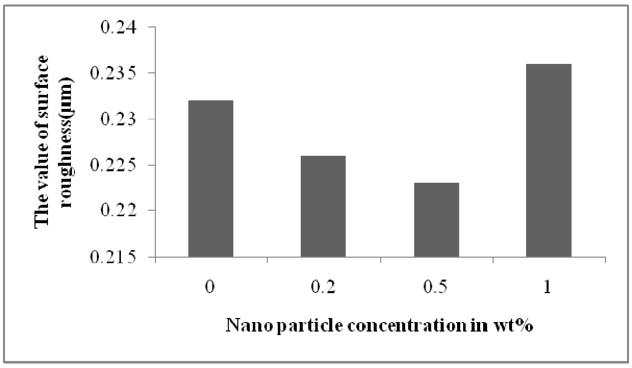


**Figure 2: Surface Roughness Values at Different Concentrations of Nano Particles**

The MQL strategy gave preferable surface roughness over dry milling and the least surface roughness was estimated as 0.8644 in nano MQL milling at 40 ml/h stream rate (Figure 3). The MQL strategy diminished the surface roughness by 8.8% and 22.5% for the stream rates of 20 ml/h and 40 ml/h, separately when contrasted with the dry processing. Also, the decreases of the surface roughness were resolved as 36.3% and 39.2% at 20 ml/h and 40 ml/stream rates in nano MQL milling, individually as compared with the dry processing. As per Figure 3, the contrast between the surface roughness was estimated at 20 ml/h and 40 ml/h stream rates was not all that much for nano fluid due to the way that the lubrication impact of nano $MoS_2$ particles had more viable than stream rate as far as the surface roughness. Be that as it may, this distinction was substantially more for pure cutting fluid. Since more blend of pressure air and cutting fluid came to the cutting zone at 40 ml/h stream rate and this created additional decrease in surface roughness [25].

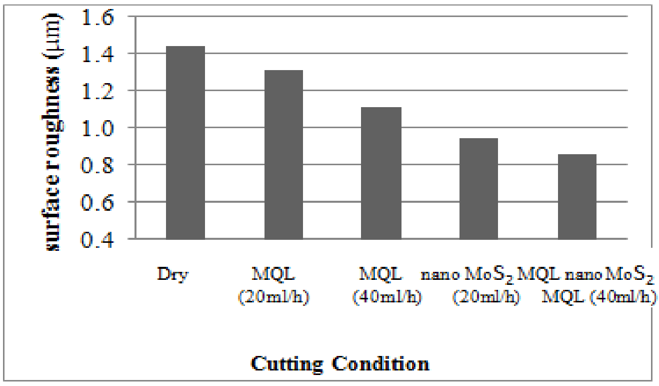


**Figure 3: Variation of Surface Roughness with Cutting Conditions**

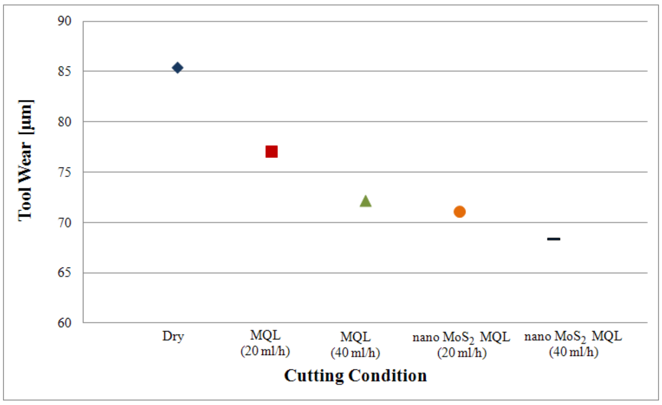


**Figure 4: Variations of Initial tool Wear with Cutting Condition**

Toward the start of the cutting activity, the cutting tools wear rapidly and lose a critical piece of their life. Therefore, it is essential to diminish the underlying tool wear. Figure 4 demonstrates the impact of cutting condition on the initial tool wear. Tool wear estimations were performed subsequently to milling for 40 seconds. The most extreme Tool wear was seen under dry milling. The MQL technique diminished the tool wear because of the way that the pounded cutting fluid had the capacity to achieve the interface between the cutting tool and workpiece. Also, the MQL stream rate had beneficial outcome on the tool wear. In this manner, the tool wear diminished with an increment of the pounded cutting fluid amount. The tool wear decreases were determined as 9.8% and 15.5% for the MQL stream rates of 20 ml/h and 40 ml/h, separately when compared with the dry milling. Furthermore, the use of nano $MoS_2$ particles fortified cutting fluid in MQL strategy gave the least tool wear because of the lubrication effect of nano $MoS_2$ particles. The pounded nano fluid decreased the friction between the cutting tool and workpiece, thus less tool wears were observed. The nano MQL technique could decrease the tool wear by 16.8% and 19.9% at 20 ml/h and 40 ml/h stream rates, individually when compared with the dry milling. The least tool wear was acquired in milling with nano $MoS_2$ particles fortified MQL strategy at 40 ml/h stream rate as found in Figure 4 [25].

## CONCLUSIONS

- In the procedure of look for options in contrast to conventional cutting fluids, solid lubricants like $MoS_2$, graphite, boric corrosive, and so on were utilized amid machining. Long way in 1972, Bartz and Muller in their examinations revealed some probable explanations for the anti-wear and anti-friction properties of $MoS_2$.

- The current research work introduced a far reaching audit of utilizing nano fluids in machining. A portion of the papers clarified that not just utilizing nano fluids effect on nano cutting fluid machining parameters yet the size, type and centralization of nano particles in base liquid are critical.

- From the literature the tests directed in dry, MQL with vegetable cutting fluid and MQL with nano fluid conditions nano $MoS_2$ particles were added to the vegetable cutting fluid. Results demonstrated that the MQL strategy could diminish the cutting forces, tool wear and surface roughness. Moreover the utilization of nano $MoS_2$ particles fortified cutting fluid in MQL milling gave the least cutting forces, tool wear and surface roughness because of the lubrication effect of nano $MoS_2$ particles.

- In conclusion, using nano cutting fluid application in machining as coolant and lubricant lead to bring down the tool temperature, tool wear, high surface quality, cutting power, surface roughness in machining with less ecological perils.

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